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(54) Low amperage microfuse

Kleinstsicherung für niedere Stromstärke

Coupe-circuit miniature pour ampérage bas

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EP 0 453 217 B1

D scription

The present invention relates to a fuse subassembly according to the preamble of claim 1.

Microfuses are physically small fuses typically used to protect electronic components used in transistorized circuitry, such as televisions, radios, computers, and other devices requiring physically small circuit interruption devices. A typical microfuse may be about 6.35 mm long and about 0.25 mm wide.

One prior art microfuse that is suitable for high speed automated assembly employs a ceramic substrate having metallized weld pads on the opposed ends thereof, having wire leads attached thereto, and a fusing link in the form of a wire ultrasonically bonded to the metallized weld pads. The substrate, with pads and wire thereon, may be coated in an arc quenching media, and then coated in a protective coating such as a plastics material.

The microfuse employing an ultrasonically bonded fusing wire has a limited range of ratings. The minimum diameter of the automatically bonded wire is too large to allow the fuse designer to achieve a fractional amperage fuse. Further, small diameter fuse wires are fragile, and as a result, the manufacture of microfuses employing such wires requires special handling to reduce the incidence of fuse wire breakage.

In response to the breakage and handling problems associated with fuse wires used in microfuses, thick film fusing links have been proposed to replace the wire fusing link in the microfuse. The thick film element is deposited directly on the substrate typically by screen printing a conductive ink. A mask is used to create a pattern having opposed welding pads for receiving fuse lead wires and a narrowed portion therebetween forming a fusing link. To change the ampere rating of the fuse, the minimum cross-sectional area of the narrowed portion (or weak spot) of the fuse is varied. For a given material for the fusing link, the narrower the cross-section, the lower the current required to cause the fuse to open. The physical properties of the thick film ink limit the minimum width of the weak spot to 2 to 8 times the typical thickness of 500 micro-inches (12.7 microns). This minimum cross-sectional area of the thick film weak spot is too large to manufacture fuses having a rated capacity below approximately 1 amp for fuse link materials of silver. Fuse link materials with higher resistivity can be used, but they result in microfuses that have higher resistance, voltage drops and body temperatures and less interrupting ability.

A more effective way to reduce the amperage rating of the fuse, is to make the fusing link and weld pads of different thicknesses. This is best achieved by printing the fuse link with a thin film ink or by the deposition of a thin film using vapour deposition, sputtering, or chemical vapour deposition techniques. However, it has been found that where the thickness of the fusing link falls below approximately 100 micro-inches (2.54 microns), the surface roughness of the substrate causes large variations of the thickness of the material forming the fusing link on the substrate, which leads to erratic fuse resistance and performance. Such erratic performance includes fuses having characteristics out of specification such as opening times, voltage drops and open fuses prior to use.

A typical ceramic substrate has an average surface roughness of approximately 10 to 40 micro-inches (0.25 - 1.0 micron). A glass-coated ceramic substrate, however, has an average surface roughness of 0.06 micro-inch (0.0015 micron). Thus, a thin film metallization with a thickness of 6 micro-inches (0.156 micron) provides a continuous layer with less than 1% cross sectional area variation. The glass layer may be 2,300 micro-inches (58.5 microns) thick.

Fuses of this type are described in WO89/08925 on which the preamble of claim 1 is based.

If the entire ceramic chip is coated with glass, however, then a second problem is encountered. To achieve high speed automated assembly of the microfuse, the external leads are resistance welded to the metallized pads at the ends of the ceramic chip. The strength of this welded joint is not acceptable if there is a glass layer between the metallization and the ceramic substrate. The thermal shock of the resistance welding operation produces microcracks in the glass layer.

The inability to manufacture microfuses (with high speed automated equipment) having amperage ratings of less than 1 amp has denied the electronics industry a low cost fractional amperage microfuse.

The present invention overcomes these deficiencies of the prior art and permits the high speed automated manufacturing of microfuses in the 1/32 to 1 amperage rage.

According to the present invention there is provided a fuse-subassembly comprising an insulative substrate, a glass insulating coating on the insulative substrate, a thin film fuse element disposed on the glass insulating coating, and metallized film lead attachment pads disposed on each end of the insulative substrate and contacting the fuse element, wherein the glass insulating coating has an average surface roughness limited to 25% of the thickness of the fuse element, characterised in that the glass insulating coating covers only a central portion of the insulative substrate leaving the ends of the insulative substrate bare and in that each of the metallized lead attachment pads extend over the edge of the glass insulating coating to provide a pad attachment portion in contact with the bare insulative substrate.

In a preferred embodiment of the present invention the glass insulating coating is provided on a ceramic, e. g. an alumina ceramic, or other insulative substrate. By restricting the glass coating to stipes on the substrate and positioning the substrate chip location properly, the glass coating is located only under the thin film fuse element and does not extend to the ends of the chip. The external leads are welded to metallizations that are ap-

plied directly onto the ceramic surface while the thin film metallization is applied to the glass-coated portion of the chip. This invention therefore provides a high strength welded joint for the external leads and a smooth surface for the thin film metallization.

The subassembly can be manufactured at low cost with selected amperage ratings between 1/32 to 1 amp.

Preferably, the insulating coating has surface dislocations i.e. abrupt stops, which are no greater than 10% of the thickness of the fuse element. Claims 6 to 8 relate to fuses comprising the fuse subassembly of the invention.

For a detailed description of a preferred embodiment of the invention, reference will now be made to the accompanying drawings, wherein:

Figure 1 is a perspective view, partially in cutaway, of a fuse incorporating the fuse subassembly of the present invention;
Figure 2 is a top view of a glass-coated ceramic substrate used to produce the individual glass-coated chips for the fuse of Figure 1;
Figure 3 is a side view of an individual glass-coated chip for the fuse of Figure 1;
Figure 4 is a top view of the chip of Figure 3;
Figure 5 is a side view of the chip of Figure 4 further including a thin film fusing link disposed on the glass portion;
Figure 6 is a top view of the chip of Figure 5;
Figure 7 is a top view of the chip of Figure 6, further including welding pads disposed thereon;
Figure 8 is a side view of the chip of Figure 7;
Figure 9 is a side view of the chip of Figure 8, further including leads disposed on the weld pads;
Figure 10 is a top view of the chip of Figure 9;
Figure 11 is a perspective view, partially in cutaway, of an alternate construction of a fuse incorporating the fuse subassembly of the present invention; and
Figure 12 is a cross-sectional view of a surface mount alternative embodiment of a fuse suitable for incorporating the fuse subassembly of the present invention.

Referring initially to Figure 1, there is illustrated a generally cylindrical subminiature fuse 10, consisting of a fuse subassembly potted within an insulative, rod-like moulded plastics body 12 and having opposed leads 14, 16 projecting from opposite ends 18, 20 thereof for connecting fuse 10 to an electrical circuit. To conduct and selectively interrupt current across fuse 10, a substrate chip 22, with welding pads 24, 26 disposed on opposed ends 28, 30 thereof, is disposed within body 12 between leads 14, 16. Each lead 14, 16 is interconnected, preferably by resistance welding, to welding pads 24, 26, respectively. Welding pads 24, 26 terminate adjacent the medial portion 32 of chip 22 where a glass coating 34 is disposed on substrate chip 22. A thin film fusing link 36 is disposed on glass coating 34, and electrically interconnects welding pads 24, 26 across the medial portion 32 of substrate chip 22. A coating of arc quenching material 38 is disposed around fusing link 36 within body 12, to reduce the duration and ultimate energy which occurs during fuse interruptions.

Referring now to Figures 2, 3 and 4, substrate chip 22 is a thin, ceramic planar member, preferably 0.025 inches (0. 64 mm) thick, which is cut from a plate 40 having alternating glass stripes 42 and bare areas 43 thereon. Plate 40 is prepared by first screen printing a silica based liquid thereon in a stripe 42 pattern, and then firing plate 40 in an oven to cure the glass stripes 42 in place on plate 40. Each of stripes 42 is preferably about 0. 0.0023 inch (0. 058 mm) thick, having an average surface roughness of typically 0.06 micro-inch (0.0015 micron). As shown in Figure 2, chip 22 is cut from plate 40 along phantom lines 44, such that each chip has a medial portion 32 covered with glass coating 34 and opposed bare sections 48, 50 on opposite sides of glass coating 34.

Referring now to Figures 5 and 6, the fusing link 36 is then placed on glass coating 34, preferably by screen printing the conductive ink directly to coating 34. Link 36 is preferably about 6 micro-inches (0.15 micron) thick. Link 36 spans coating 34 and includes opposed weld pad interfaces 52, 54 and a neck down area 56 therebetween. Neck down area 56 is a reduced width portion of fusing link 36 and may be varied in width. During manufacture of fuse 10, the width of neck down area 56 is sized for a particular amperage rating. The wider the width of neck down area 56, the greater the current carrying capacity of fuse 10.

Referring now to Figures 7 and 8, weld pads 24, 26 are thick film screen printed on substrate chip 22, on glass coating 34 and portions of bare portions 48, 50 by using a conductive ink. Weld pads 24, 26 each include an enlarged portion 58 disposed on bare sections 48, 50, respectively, of substrate chip 22, and a cantilevered portion 60 extending onto glass coating 34 and weld pad interfaces 52, 54, respectively. Leads 14, 16 are then applied to enlarged portions 58 of weld pads 24, 26, respectively, preferably by resistance welding. The isolation of the welding to the enlarged portion 58 avoids cracking the glass coating 34 due to thermal stress during the welding operation.

Referring now to Figures 1, 10 and 11, once leads 14, 16 are attached to substrate chip 22, the coating of arc quenching material 38 is applied to substrate chip 22 over fusing link 36, and the entire assembly is then placed in a mould. Plastics body 12 is then injection moulded thereabout, leaving the ends of leads 14, 16 projecting therefrom.

Referring now to Figures 11 and 12, alternate embodiments of a fuse package suitable for incorporating a fuse subassembly according to the present invention are shown. In Figure 11, a fuse 70, employing substrate chip 22, includes leads 14, 16 which project parallel to each other from the same side of substrate chip 22 to

form a clip type, as opposed to cylindrical, subminiature fuse. In Figure 12, a fuse package 80, employing substrate chip, includes leads 14, 16 which are flat and bend around the body of the fuse 80. The fuse package of Figure 12 is described in US-A-4,771,260.

By employing a smooth coating, such as glass, under the fusing link, thin film technology may be employed to create a subminiature fuse with ampere ratings below one amp. The glass coating provides one additional benefit. Since the thermal conductivity of glass is significantly lower than that of alumina, more of the heat generated in the fuse element is retained in the element and the time required to melt the element for a given overload current condition is reduced. It should be appreciated that this invention may be employed in large amperage fuses by enlarging the cross-section of the necked down portion 54, and where appropriate, that of the entire fuse link. Further, although a 6 micro-inch (0.15 micron) thin fuse link 36 has been described, other thicknesses may be employed.

The moulded body 12 may be replaced by an insulating tube.

Claims

1. A fuse subassembly comprising an insulative substrate (22), a glass insulating coating (34) on the insulative substrate (22), a thin film fuse element (36) disposed on the glass insulating coating (34), and metallized film lead attachment pads (24, 26) disposed on each end of the insulative substrate (22) and contacting the fuse element (36), wherein the glass insulating coating (34) has an average surface roughness limited to 25% of the thickness of the fuse element (36), characterised in that the glass insulating coating (34) covers only a central portion of the insulative substrate (22) leaving the ends of the insulative substrate (22) bare and in that each of the metallized lead attachment pads (24, 26) extend over the edge of the glass insulating coating (34) to provide a pad attachment portion disposed on the bare insulative substrate (22).

2. A fuse subassembly according to claim 1, wherein the glass insulating coating has surface dislocations no greater than 10% of the thickness of the fuse element (36).

3. A fuse subassembly according to claim 1 or 2, wherein the fuse element (36) is less than 100 micro inches (2.54 microns) thick.

4. A fuse subassembly according to any one of the preceding claims, wherein the insulative substrate (22) is ceramic.

5. A fuse subassembly according to any one of the preceding claims, further comprising an arc quenching coating (38) substantially covering the fuse element (36).

6. A fuse (10;70;80) comprising a fuse subassembly of any one of the preceding claims with leads (14, 16) attached to and projecting from the pad attachment portions (58) of the lead attachment pads (24, 26).

7. A fuse (10) according to claim 6, in which the fuse subassembly is potted in a moulded plastics enclosure (12) with the leads (14, 16) projecting therefrom.

8. A fuse (10) comprising a tube (12) of insulating material in which is housed the fuse subassembly according to any one of claims 1 to 5 and wherein electrically conductive end caps (18) mate with the tube (12) and make electrical contact with the lead attachment pads (24, 26).

Patentansprüche

1. Sicherungs-Teilbaugruppe, die ein isolierendes Substrat (22), eine Glas-Isolierbeschichtung (34) auf dem isolierenden Substrat (22), ein Dünnschicht-Sicherungselement (36), das auf der Glas-Isolierbeschichtung (34) angeordnet ist, und Metallfilm-Leiteranschlußstellen (24, 26) umfaßt, die an jedem Ende des isolierenden Substrats (22) angeordnet und mit dem Sicherungselement (36) in Kontakt sind, wobei die Glas-Isolierbeschichtung (34) eine durchschnittliche Oberflächenrauhheit aufweist, die auf 25% der Dicke des Sicherungselementes (36) beschränkt ist, dadurch gekennzeichnet, daß die Glas-Isolierbeschichtung (34) nur einen Mittelabschnitt des isolierenden Substrats (22) bedeckt, wobei die Enden des isolierenden Substrats (22) unbedeckt sind, und daß jede der Metall-Leiteranschlußstellen (24, 26) sich über den Rand der Glas-Isolierbeschichtung (34) hinaus erstreckt, so daß ein Anschlußstellen-Anbringungsabschnitt entsteht, der auf dem unbedeckten isolierenden Substrat (22) angeordnet ist.

2. Sicherungs-Teilbaugruppe nach Anspruch 1, wobei die Glas-Isolierbeschichtung Oberflächenversetzungen aufweist, die nicht mehr als 10% der Dicke des Sicherungselementes (36) betragen.

3. Sicherungs-Teilbaugruppe nach Anspruch 1 oder 2, wobei das Sicherungselement (36) weniger als 100 Mikroinch (2,54 μm) dick ist.

4. Sicherungs-Teilbaugruppe nach einem der vorangehenden Ansprüche, wobei das isolierende Sub-

strat (22) aus Keramik besteht.

5. Sicherungs-Teilbaugruppe nach einem der vorangehenden Ansprüche, die des weiteren eine Lichtbogenlöschbeschichtung (38) umfaßt, die das Sicherungselement (36) im wesentlichen bedeckt.

6. Sicherung (10; 70; 80), die eine Sicherungs-Teilbaugruppe nach einem der vorangehenden Ansprüche umfaßt, wobei Leiter (14, 16) an den Anschlußstellen-Anbringungsabschnitten (58) der Leiteranschlußstellen (24, 26) angebracht sind und von ihnen vorstehen.

7. Sicherung (10) nach Anspruch 6, wobei die Sicherungs-Teilbaugruppe in einer Umhüllung (12) aus geformtem Kunststoff vergossen ist, wobei die Leiter (14, 16) daraus vorstehen.

8. Sicherung (10), die eine Röhre (12) aus isolierendem Material umfaßt, in der die Sicherungs-Teilbaugruppe nach einem der Ansprüche 1 bis 5 aufgenommen ist, wobei elektrisch leitende Abschlußkappen (18) mit der Röhre (12) in Eingriff sind und elektrischen Kontakt mit den Leiteranschlußstellen (24, 26) herstellen.

Revendications

1. Sous-ensemble de fusible comprenant un substrat isolant (22), un revêtement isolant en verre (34) sur le substrat isolant (22), un élément de fusible à film mince (36) disposé sur le revêtement isolant en verre (34), et des patins (24,26) de fixation de conducteur à film métallisé, disposés sur chaque extrémité du substrat isolant (22) et en contact avec l'élément fusible (36), dans lequel le revêtement isolant en verre (34) a une rugosité de surface moyenne limitée à 25% de l'épaisseur de l'élément fusible (36), caractérisé en ce que le revêtement isolant en verre (34) couvre seulement une partie centrale du substrat isolant (22), laissant les extrémités du substrat isolant (22) découvertes et en ce que chaque patin de fixation conducteur métallisé (24,26) s'étend sur le bord du revêtement isolant en verre (34) pour fournir une portion de fixation de patin disposée sur le substrat isolé découvert (22).

2. Sous-ensemble de fusible selon la revendication 1, dans lequel le revêtement isolant en verre a des défauts de surface pas plus grands que 10% de l'épaisseur de l'élément fusible (36).

3. Sous-ensemble de fusible selon la revendication 1 ou 2, dans lequel l'élément fusible (36) présente une épaisseur inférieure à 2,54 µm (100 µ inches).

4. Sous-ensemble de fusible selon l'une quelconque des revendications précédentes, caractérisé en ce que le susbtrat isolant (22) est en céramique.

5. Sous-ensemble de fusible selon l'une quelconque des revendications précédentes, comprenant en outre un revêtement (38) de soufflage d'arc couvrant substantiellement l'élément fusible (36).

6. Fusible (10;70;80) comprenant un sous-ensemble de fusible selon l'une quelconque des revendications précédentes, avec des conducteurs (14,16) attachés à et s'étendant à partir des portions de fixation de patin (58) des patins de fixation de conducteur (24,26).

7. Fusible selon la revendication 6, dans lequel le sous-ensemble de fusible est disposé dans une enceinte (12) en plastique moulé avec les conducteurs (14,16) s'étendant à partir de celle-ci.

8. Fusible (10) comprenant un tube (12) de matériau isolant, dans lequel est disposé le sous-ensemble de fusible selon l'une quelconque des revendications 1 à 5 et dans lequel des capuchons d'extrémité (18) conducteurs de l'électricité correspondent avec le tube (12) et font contact électrique avec les patins de fixation de conducteur (24,26).

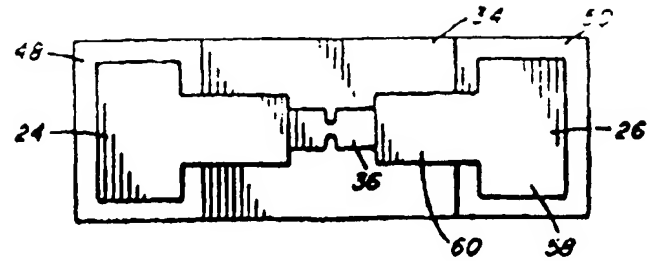

FIG. 7

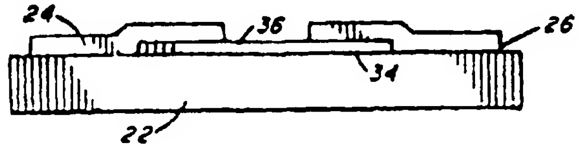

FIG. 8

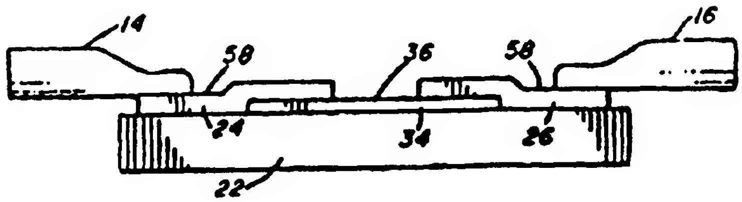

FIG. 9

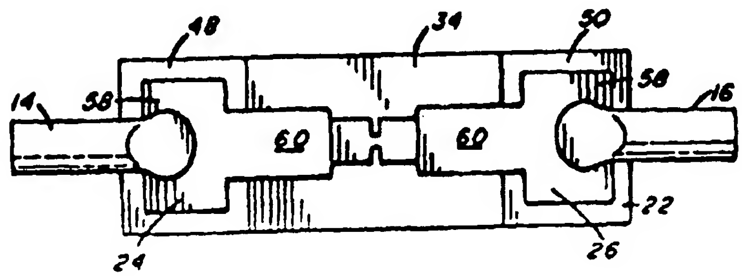

FIG. 10

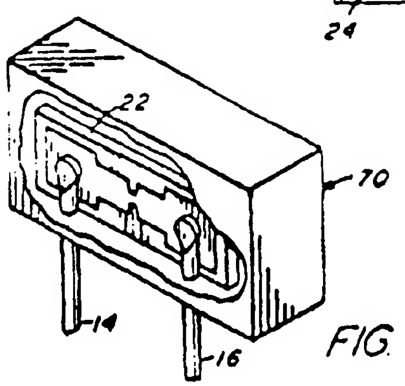

FIG. 11

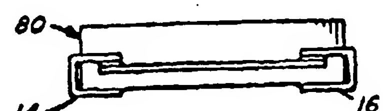

FIG. 12

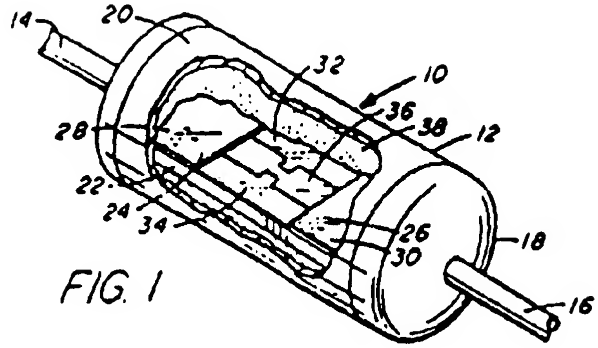

FIG. 1

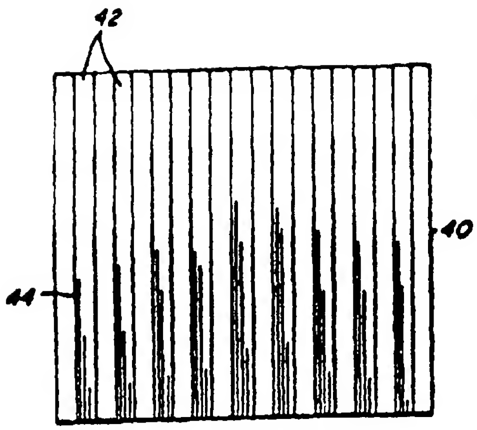

FIG. 2

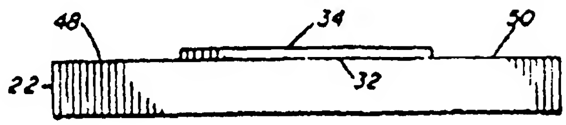

FIG. 3

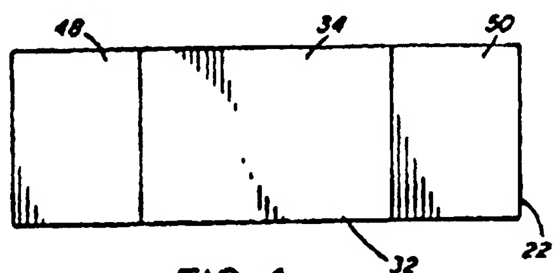

FIG. 4

FIG. 5

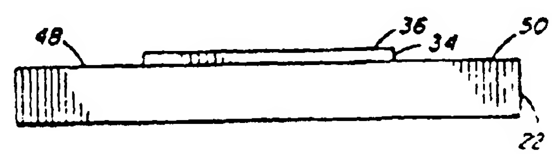

FIG. 6